LACE
nwp central europe

ALARO and AROME DA systems in LACE

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DHMZ SHMÚ OMSZ ZAMG ROMANIA ANM

Operational DA systems

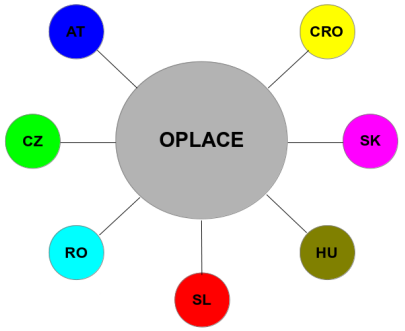
- LACE data assimilation activities are covering works from ***7 member countries*** (At, Cz, Cr, Hu, Sk, Sl, Ro).
- Recently ***9 different operational DA systems*** exist which are not just developed, but have to be maintained by the colleagues.

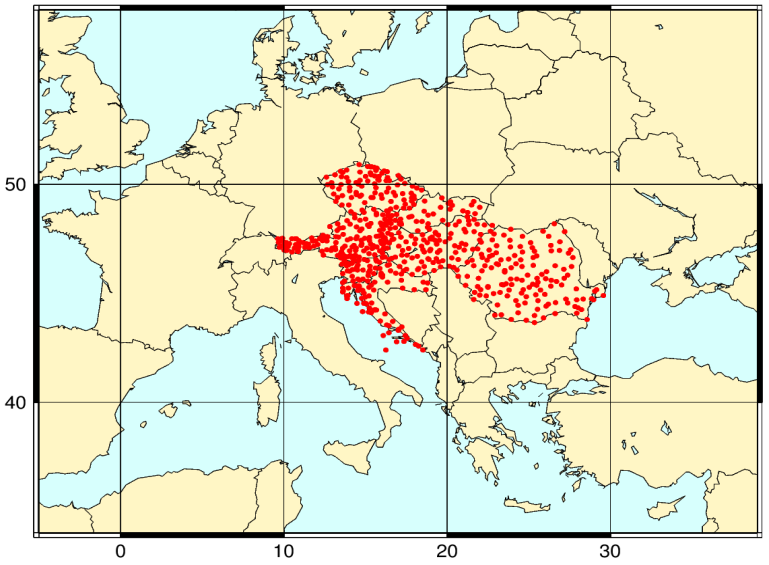
  - AROME(2.5L90) **OI_main + 3DVAR 3h RUC** Austria
  - ALARO(4.8L60) **OI + IFS DSC** Austria
  - ALARO(4.7L87) **OI + DFBlending + 3DVAR** Czech Republic
  - ALARO(8L37) **OI + 3DVAR** Croatia
  - AROME(2.5L60) **3DVAR 3h RUC** Hungary
  - ALARO(8L49) **OI + 3DVAR** Hungary
  - ALARO(4.4L87) **OI + 3DVAR 3h RUC** Slovenia
  - ALARO(9L37) **OI + DFBlending** Slovakia
  - ALARO(4.5L63) **OI + DFBlending** Slovakia

- and additionals in pre-op phase

  - ALARO(4) OI + IFSDSC Croatia
  - ALARO(6.5L49) OI + 3DVAR Romania

Observation pre-processing system for LACE (OPLACE)





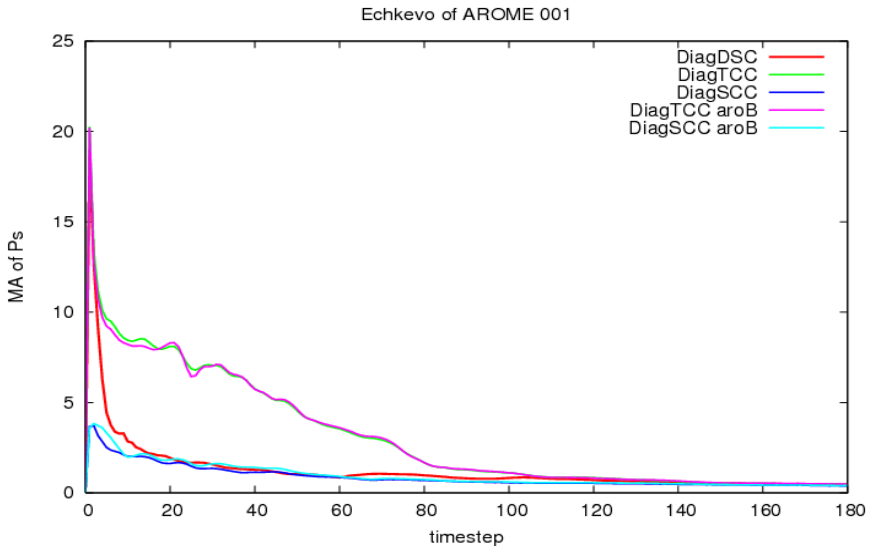
Outline

- Introduction i.e. operational DA systems
- Towards frequently updated analysis cycle
- Surface assimilation based on EKF
- Assimilation of HRW AMVs
- The use of Mode-S observations inside LACE
- Questions

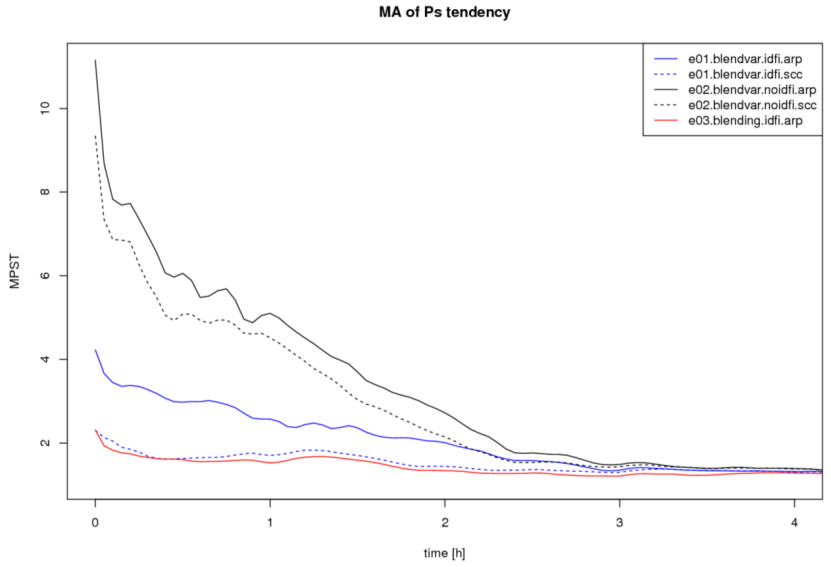
Towards frequently updated analysis cycle

- Many LACE countries are interested to develop further their DA systems towards a Rapid Update Cycle (RUC) approach and benefit from the increased analysis frequency.
- Challenges with the control of noise accumulation, the use of high resolution observations and better representation of large-scales and background errors are undertaken.
- For the planning and cooperation a special meeting has been organized in 2015. (Materials can be found: http://www.rclace.eu/?page=11)

Domain diagnositc with AROME/Hungary

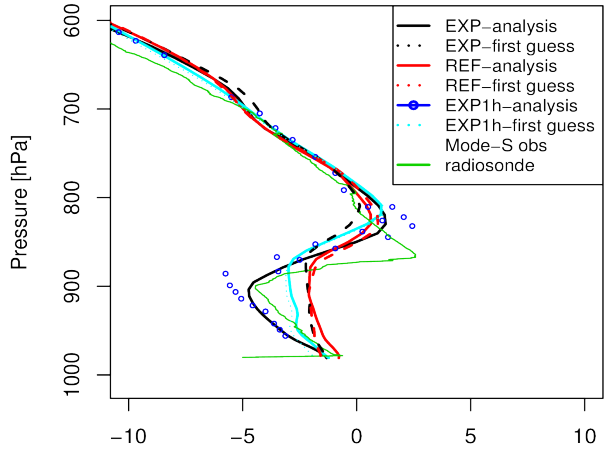


Benacek: Testing IDFI for ALARO BlendVar

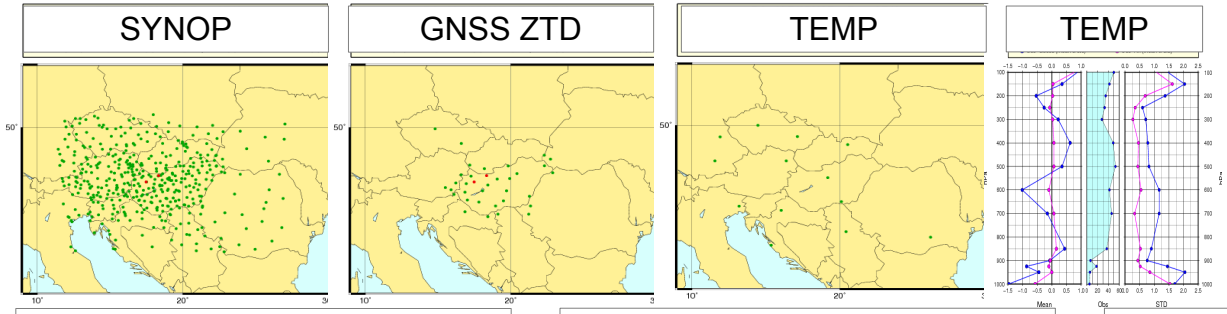


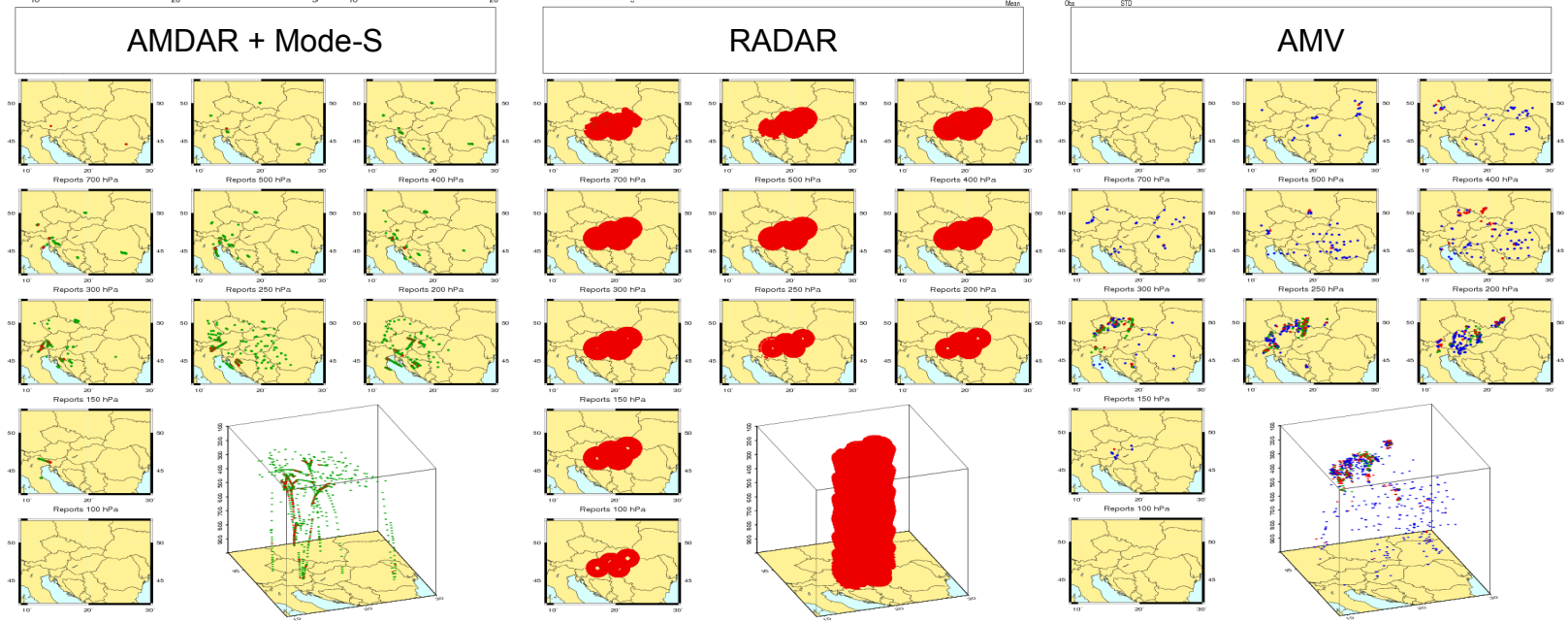
Towards frequently updated analysis cycle

- OPLACE common observation pre-processing
- Observation inventory



Strajnar: 1h RUC vs 3h RUC





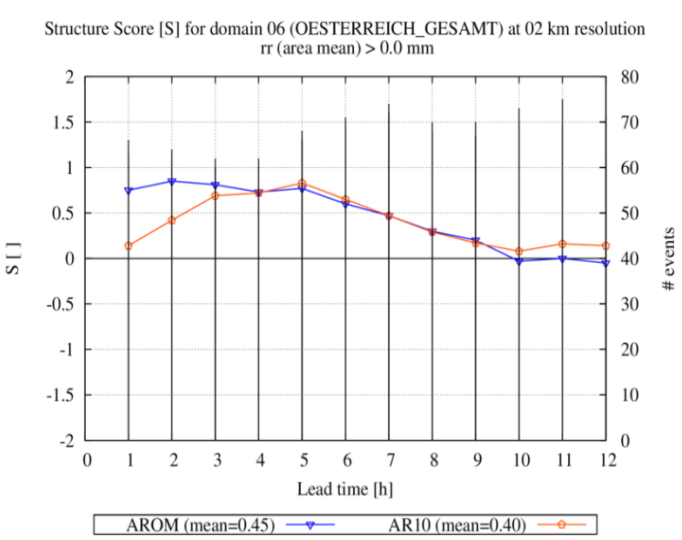
Towards frequently updated analysis cycle

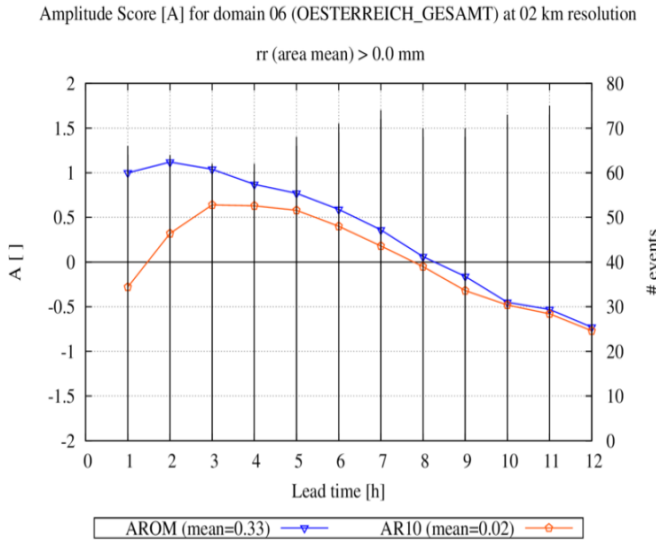
- First results about a non-cycled hourly analysis of AROME/Austria suggest the benefit of the increased analysis frequency.
- Verification has been done on the period of July-August 2015.
- RADAR reflectivity and radial wind observations are used only in hourly analyses which again are identified as necessary component of such system.

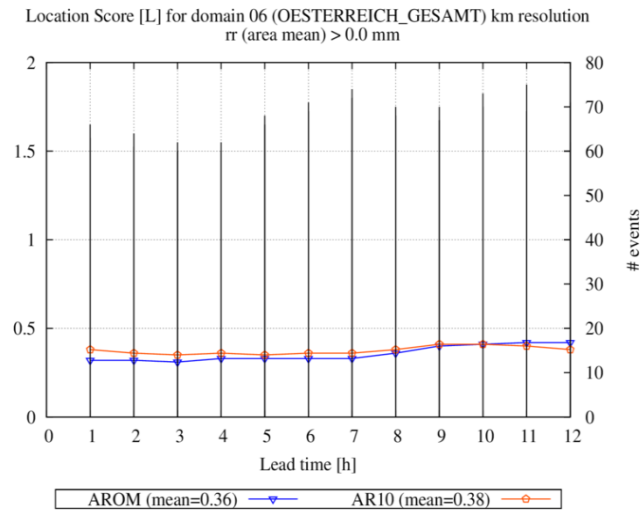
SAL verification of AROME/Austria

AROME - 3 hourly OPER

AROME – 1 hourly Nowcasting







From Florian Meier, ZAMG Austria

Surface assimilation using extended Kalman Filter approach

- Optimal interpolation for surface analysis is widely used in LACE, however, it has several limitations
- Extended Kalman Filter approach is under development to replace OI analyses in LACE and also to consider non-conventional surface observations.
- From a EU-FP7 Imagines project, the EKF was proven to be beneficial using various satellite surface products to be assimilated.

$$x_t^a = x_t^b + \mathrm{K}(y_t^o - H(x_0^b))$$

$$\mathrm{K} = \mathrm{B}\mathrm{H}^T(\mathrm{H}\mathrm{B}\mathrm{H}^T + \mathrm{R})^{-1}$$

$$\mathrm{A} = (\mathrm{I} - \mathrm{K}\mathrm{H})\mathrm{B}$$

$$\mathrm{H} = \frac{\partial \mathrm{y_t}}{\partial \mathrm{x_0}}$$

$$H_{ij} = \frac{\partial y_i}{\partial x_j} \approx \frac{y_i(x + \delta x_j) - y_i(x)}{\delta x_j}$$

Oper purposes

H: TG1, TG2, WG1, WG2

Obs.: T2m, Rh2m

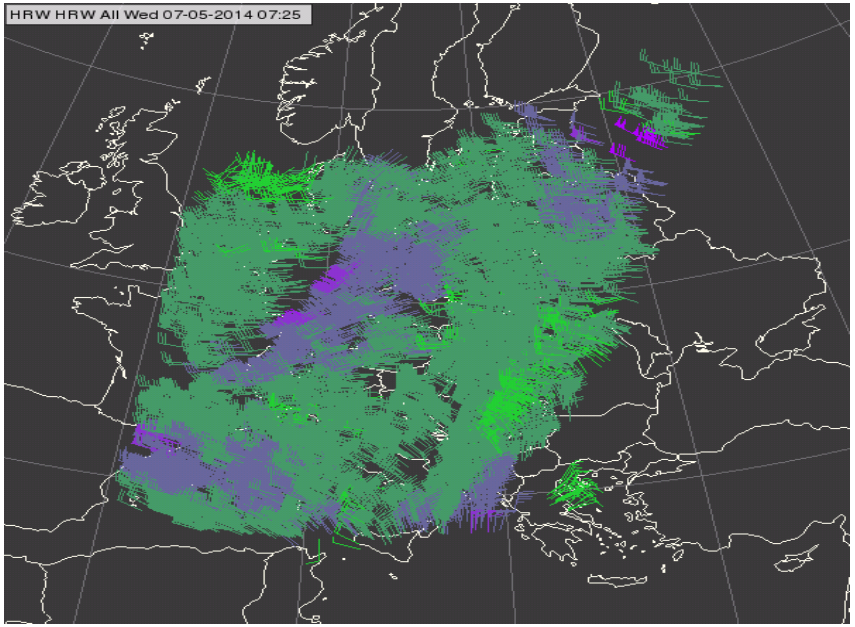
Project purposes

H: LAI WG1, WG2

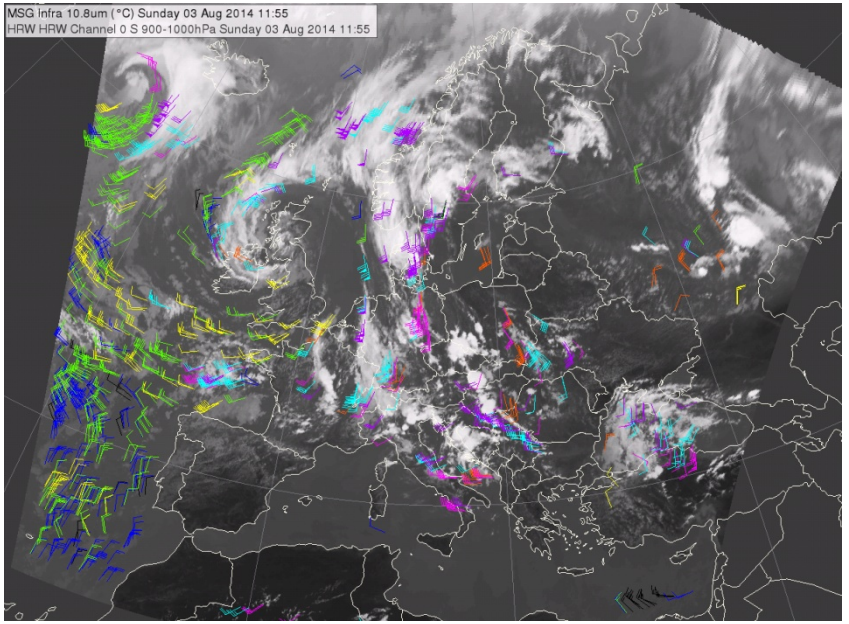
Obs.: LAI SSM

The use of HRW AMVs in AROME 3DVAR

- NWCSAF package v2013 contains advanced retrieval algorithm of AMV so called HRW (High Resolution Winds).
  - BUFR format for data assimilation
  - Output filtering threshold: QI_THRESHOLD = 70%
  - Channels to be used for AMV retrieval: HRVIS, VIS08, IR108, WV062, WV073
  - Without using wind guess information WIND_GUESS = 0
- The High Resolution Winds AMV observation is now available via OPLACE for users besides MPEF(Geowind) AMVs.



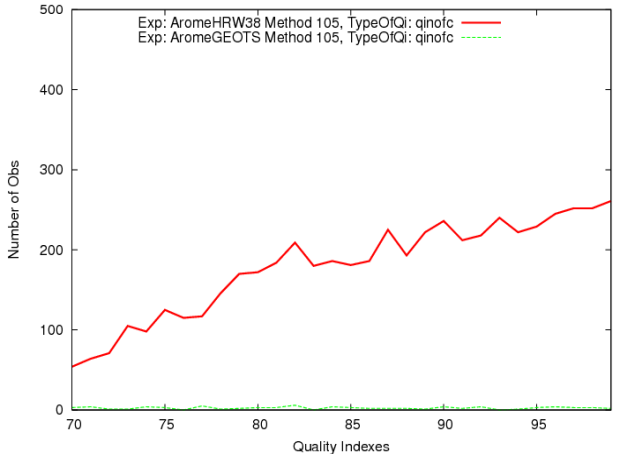
HRW vectors retrieved from 5 channels for 5th of July 2014

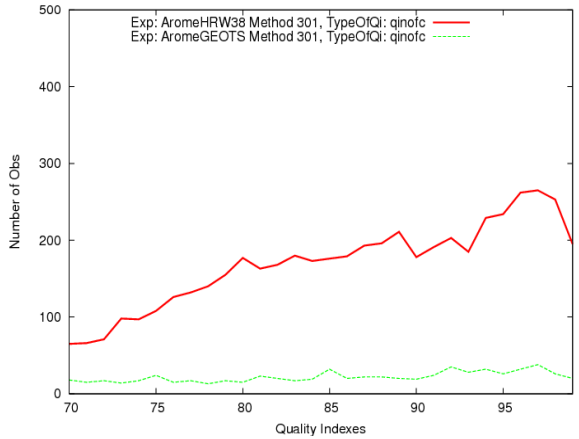


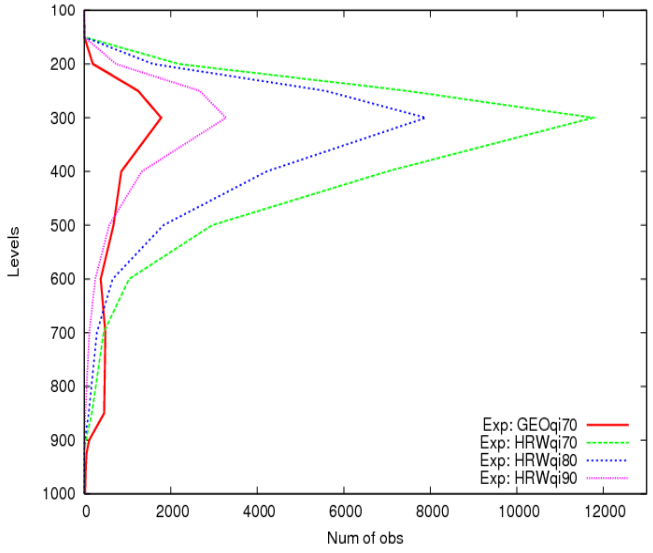
HRW vectors retrieved from IR10.8 channel for 12UTC, 3rd of August 2014

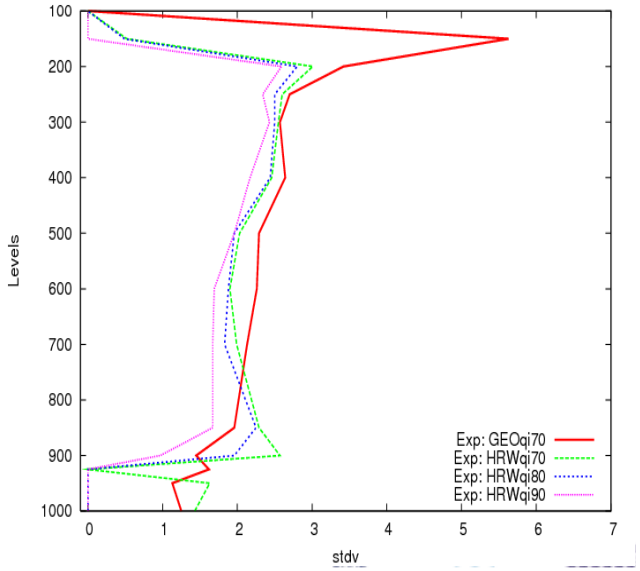
The use of HRW AMVs in AROME 3DVAR

- The number of HRW observation as a function of quality indices
  - Method105(WV062)
  - Method301(IR108)
- HRW provides increased number of AMVs and usually more with higher QIs
- On a relatively small domain, the amount of HRW observations is still plausible





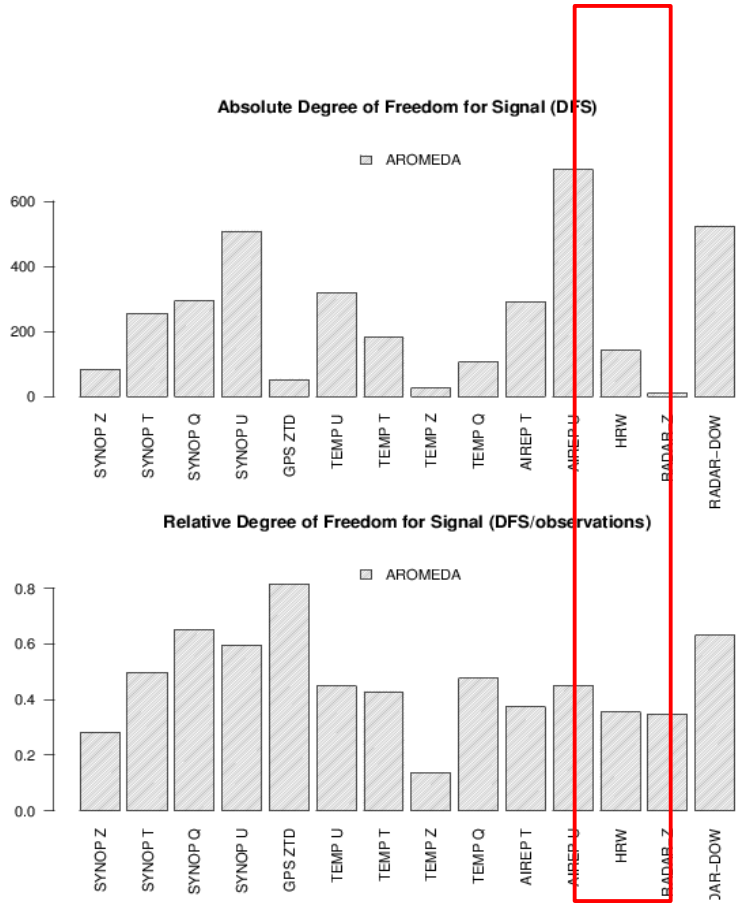


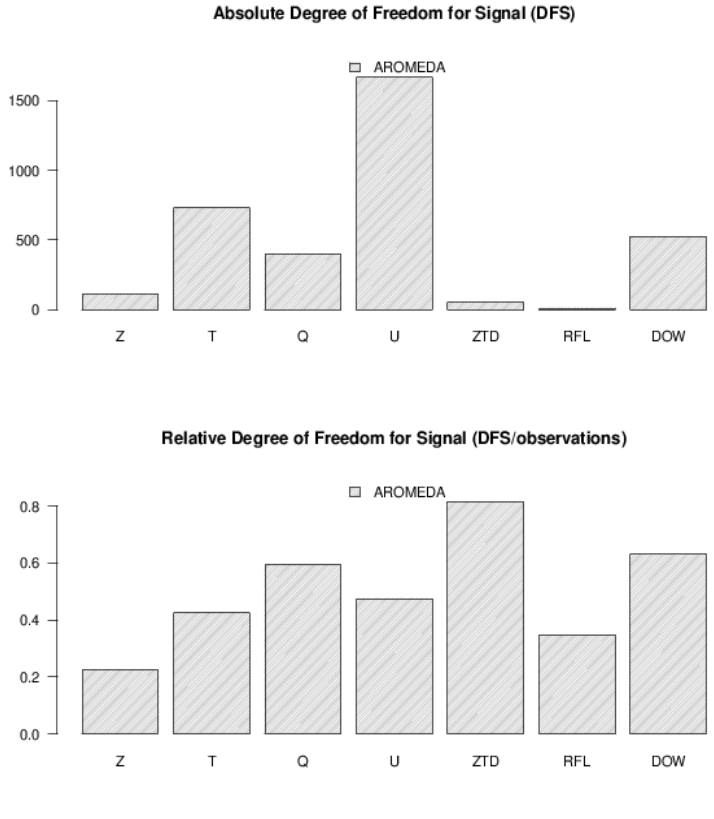


GEOqi70 MPEF AMV above 70%
HRWqi70 HRW AMV above 70%
HRWqi80 HRW AMV above 80%
HRWqi90 HRW AMV above 90%

The use of HRW AMVs in AROME 3DVAR

- Regarding DFS diagnostic tool, HRW has small absolute contribution due to the small amount of observations compared to other types
- On the other hand the relative contribution is not negligible and comparable with conventional observations.





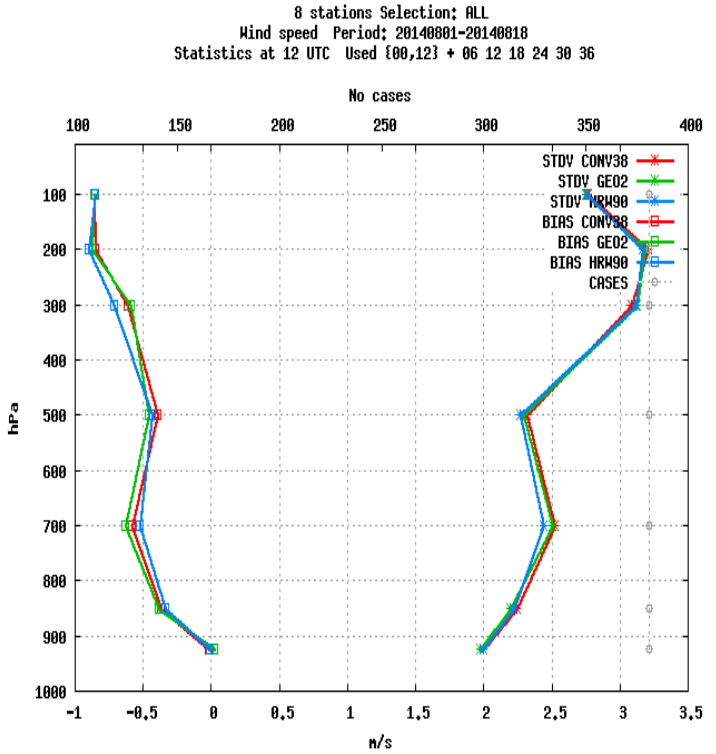
The use of HRW AMVs in AROME 3DVAR

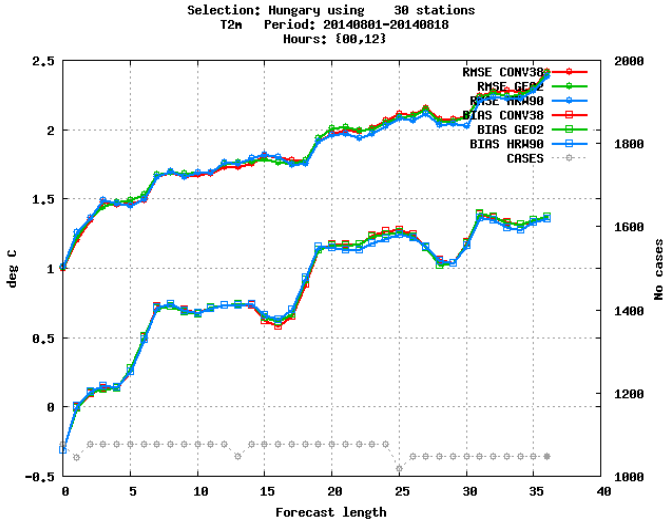
- Due to the results of the impact study, we can conclude that HRW has overall neutral impact, but for particular cases studies (especially for convective precipiation events) the use of HRW is beneficial.
- The impact of Geowind AMV was tested also beside HRW in AROME, but the impact was even smaller due to the very small amount of Geowind AMV inside AROME domain

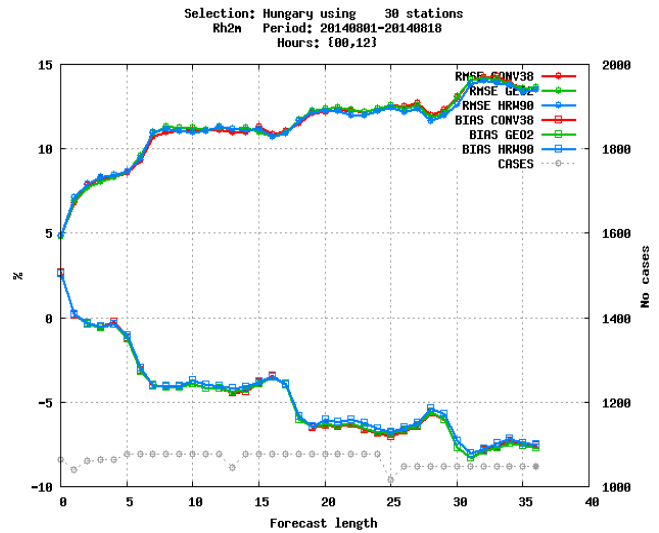
AROME CONV38 – Red (Oper AROME/Hu)

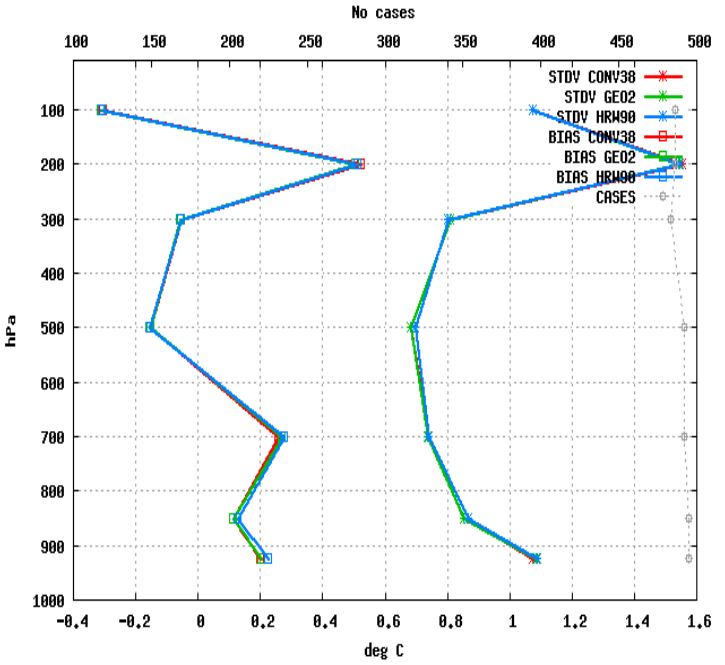
AROME GEO2 – Green (Geowind AMV used)

AROME HRW90 – Blue (HRW AMV used)

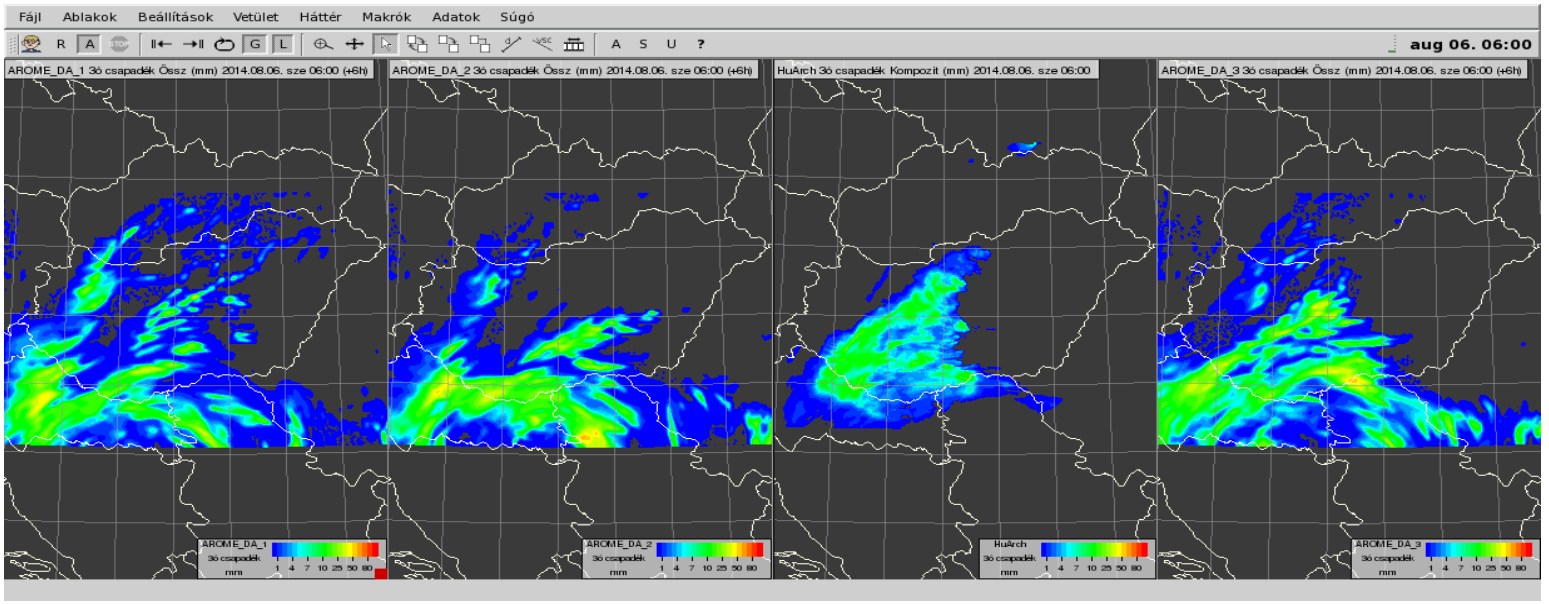




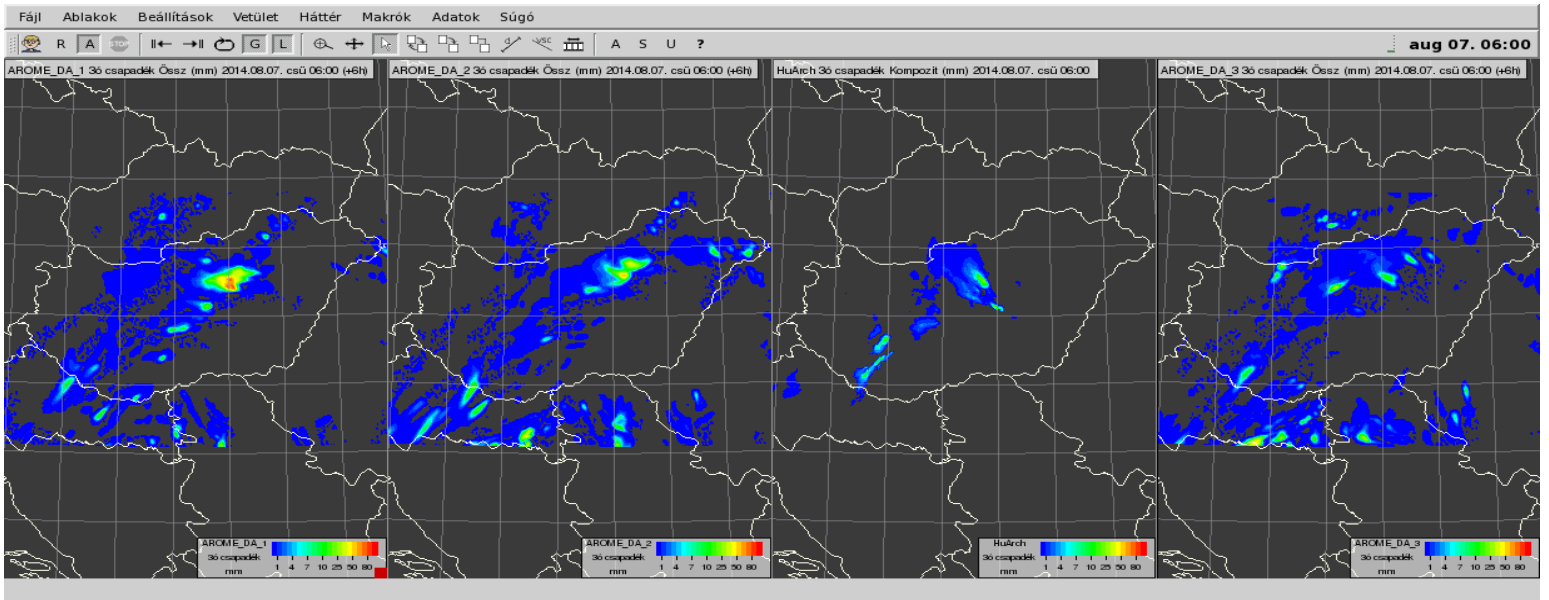




Case studies (HRW)



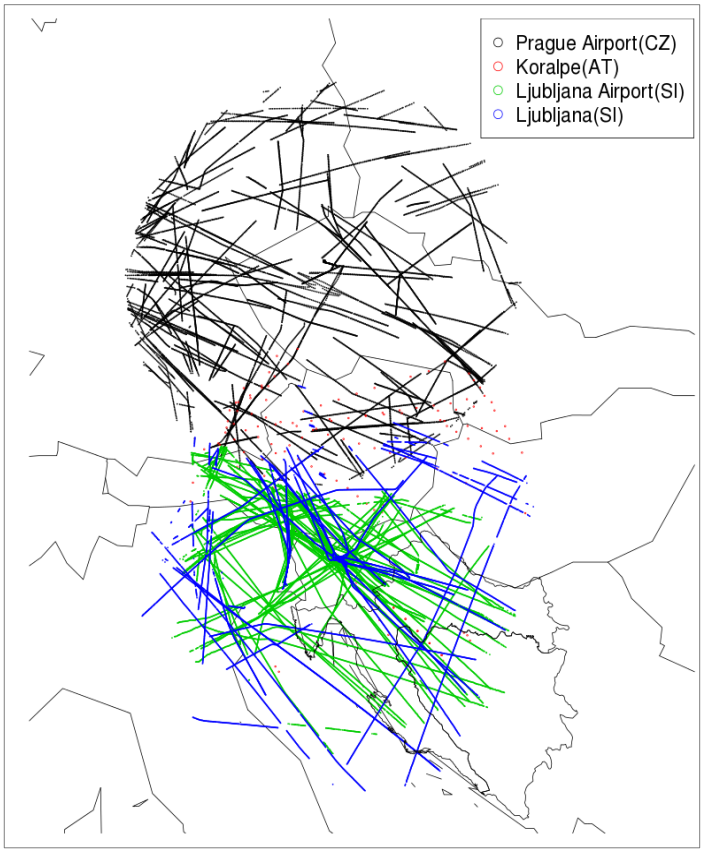
3h AROME/Hungary precipitation forecasts for 6th of August, 2014. 1.panel: Without AMV, 2.: with MPEF AMV, 3.: RADAR observation, 4.: with HRW AMV

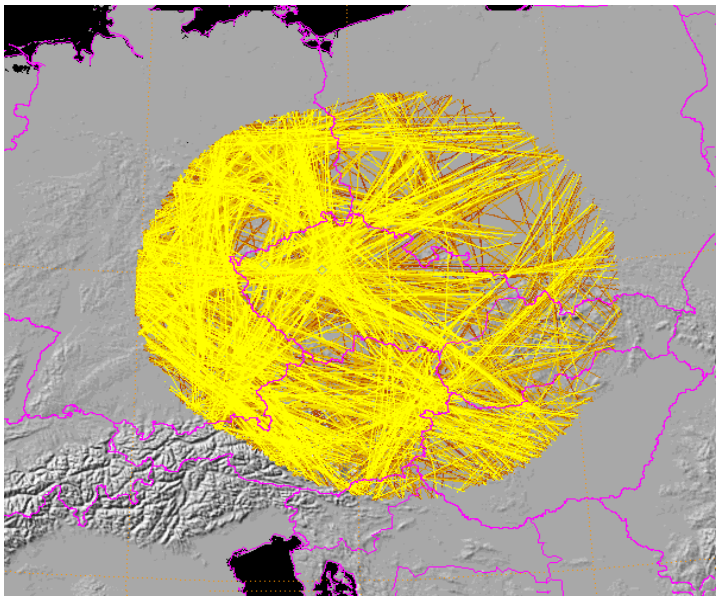


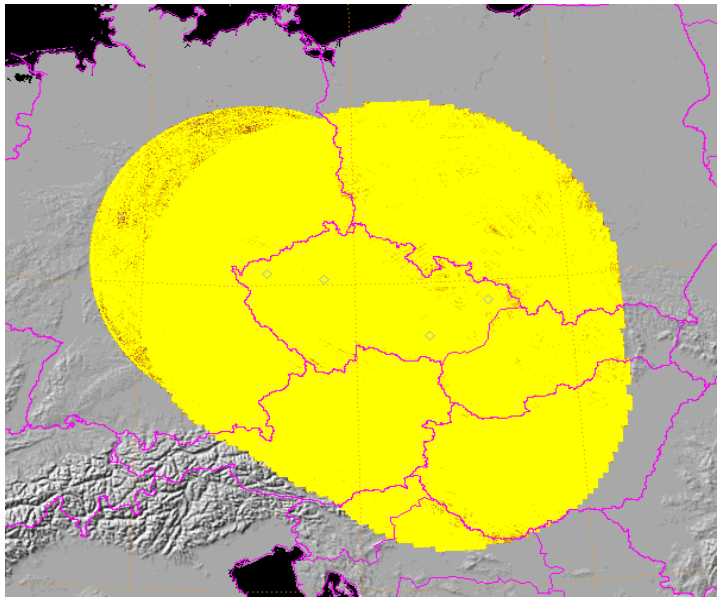
3h AROME/Hungary precipitation forecasts for 7th of August, 2014. 1.panel: Without AMV, 2.: with MPEF AMV, 3.: RADAR observation, 4.: with HRW AMV

The use of Mode-S in LACE

- Mode-S observations have a growing network in Europe
- In Slovenia Mode-S MRAR observations are already used from 2 radars in operational ALARO DA suite.
- In Czech Republic Mode-S EHS and MRAR reports are collected and studied in the frame of a collaboration with Czech Air Traffic Control.
- Mode-S observations are expected to be available soon from other LACE countries as well (Austria, Hungary)







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The use of Mode-S in LACE

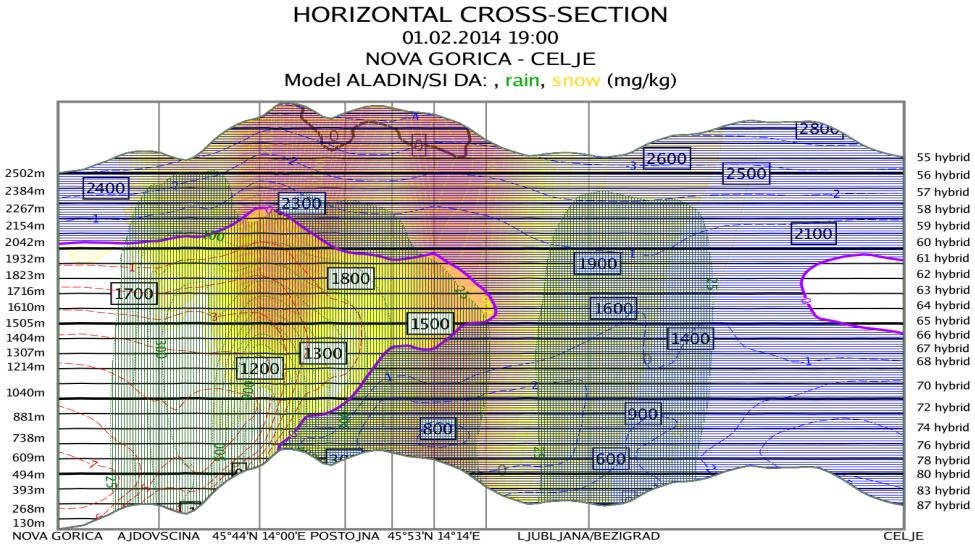
- Reminder:

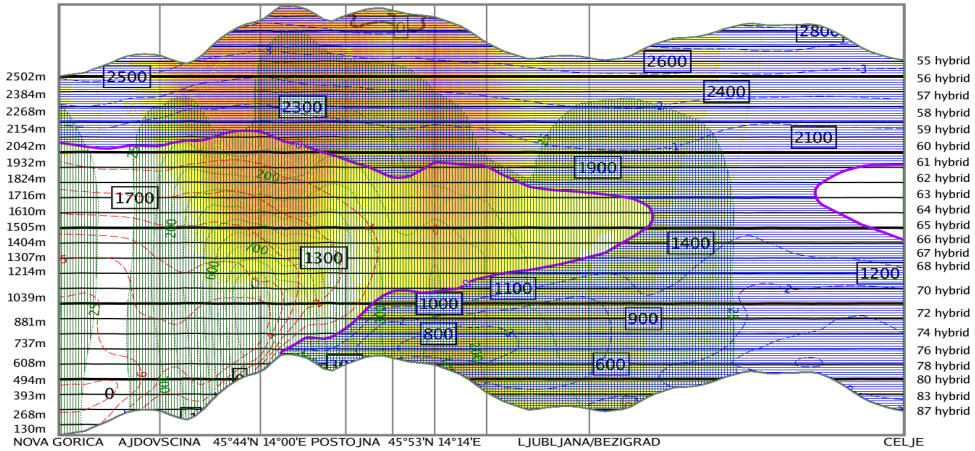
	MODE-S MRAR	MODE-S EHS
name	*Meteorological routine air report*	*Enhanced surveilance (reports)*
data	(BDS 4,4) – met. routine air report wind speed, direction, temperature turbulence, humidity (BDS 4,5) – met. hazard report (turbulence, wind shear,microburst,icing)	(BDS 4,0) selected vertical intent (selected altitude) (BDS 5,0) track and turn report - roll angle, true track angle and rate, ground speed and true air speed (BDS 6,0) heading and speed report indicated air speed and mach, barometric altitude rate, magnetic heading
type	Direct data	Indirect (temperature) data
rep. by	around 5 % of all Mode-S equipped aircraft (depends on transponder configuration)	all Mode-S equipped aircraft
	Strajnar 2012, Hrastovec and Solina 2013	*de Hann 2011, de Haan and Stoffelen 2012*

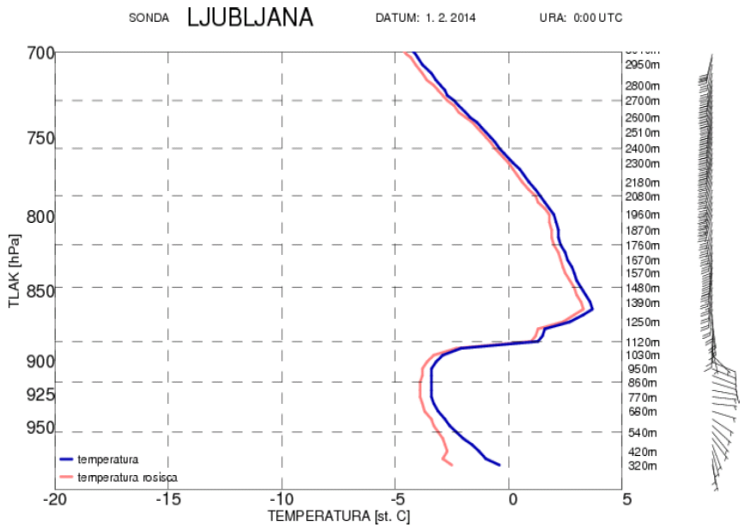
- From Benedikt Strajnar, ARSO Slovenia

The use of Mode-S in LACE

(Case study of the Slovenian freezing rain event at 1st of February 2014)







- From Benedikt Strajnar, ARSO Slovenia

Thank You for your attention!

Thank You for colleagues who contributed!

Questions?